



Setting the New Standard In Motors And Generators

July 2010

www.lt-eng.com





Things really do change.....

A Couple Simple Thoughts to Remember...

Efficiency: Key to Our Electric Future

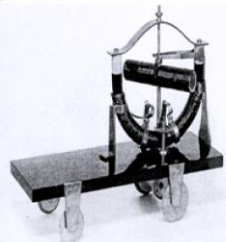
"There's a way to do it better – find it." – Thomas A. Edison

“Material science breakthroughs and advancements lead to product innovations”

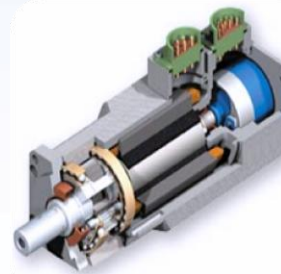
“Smaller and lighter motors cost less to build and use less material”



Innovation Happens....



Jedlik's electric-car in 1828, Hungary
(Museum of Hungarian Electrical Engineering)



1831
Invention of the first
electrical motor

1880s
Tesla develops the
first modern AC
induction motor –
foundation of the
industrial revolution

1980s
Modern rare-earth
high-energy
magnets developed
for electric motors –
enables small
motor applications
(e.g., disk drives)

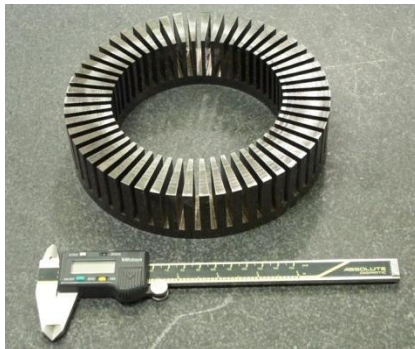
Present
Amorphous metals
introduced as the
magnetic material –
will enable markets
challenged by
existing motor
technology



What do we do at LE?

•LE's exclusive technology leverages amorphous metals' into rotating electric machines which realizes greater energy efficiencies, smaller machine sizes and cost-competitiveness. While we are in production with many finish-level products today, our role is that of a Technology Provider to meet market needs in:

- HEV / EV Traction Applications**
- Power Generation, Mobile Power Systems. Etc**
- Industrial Motors, Commercial HVAC, Pumps, Etc**
- High Speed/Frequency Power Systems**





What are Amorphous Metals?



- **Iron based material fabricated via rapid solidification resulting in little to no crystalline matrix within the yielded material.**
- **Amorphous metal manufacturing was developed by Allied Chemical in association with the Electric Power Research Institute in 1975,**
- **The resulting amorphous metal was inexpensive, and very low loss**
- **It was, however, brittle and very difficult to fabricate into motors**
- **LE developed proprietary low-cost manufacturing technologies that now enable the use of amorphous metal in Axial configuration motors and generators**
- **Today over 100,000 metric tons of the material is produced every year.**





Light Engineering, Inc. Innovation Timeline.....

'98 to '01

Invention

'01 to '04

**Prototypes &
Model Development**

'04 to '06

**Process & Advanced
Development &
Applications**

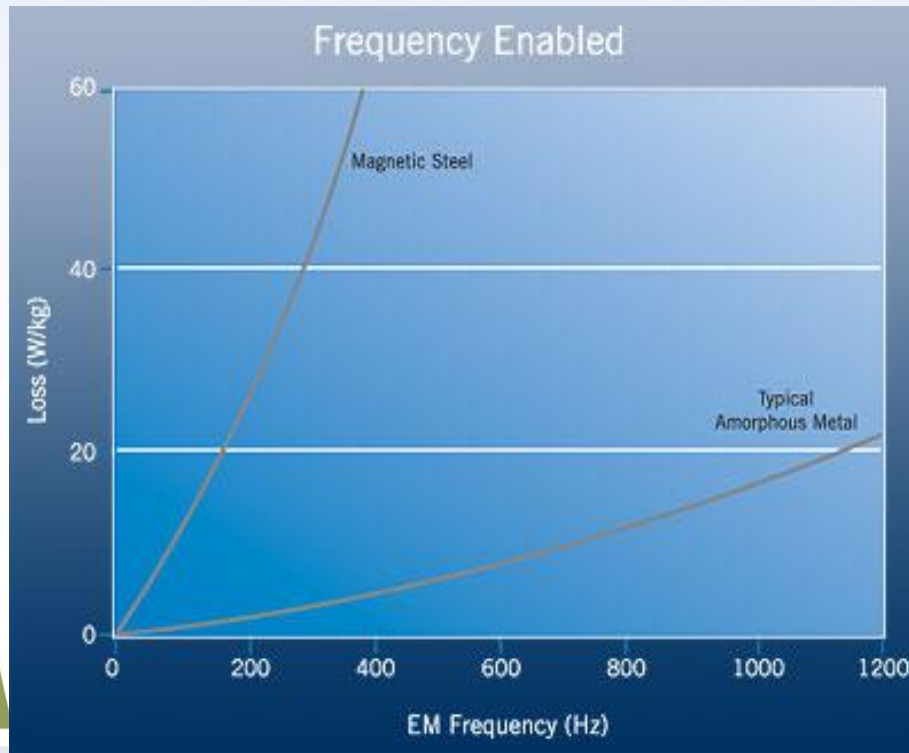
'07 to '09

**Product
Commercialization**

**Timeline of LE Amorphous Axial
Gap Machine Development**



How did we solve the problem ?



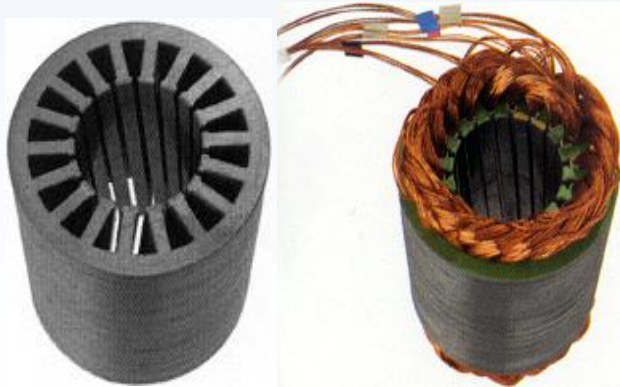
Advantages

1. Increased power for the same machine size and active material content.
2. A net increase in machine efficiency.
3. Increased power density (power/weight, power/volume) at a REDUCED COST for a given power.

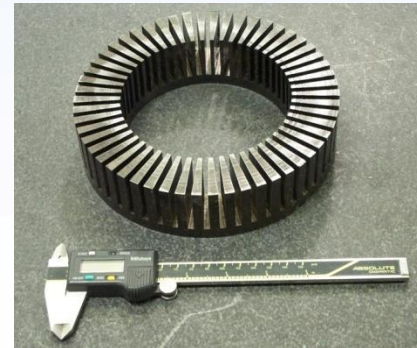


Technology Transition

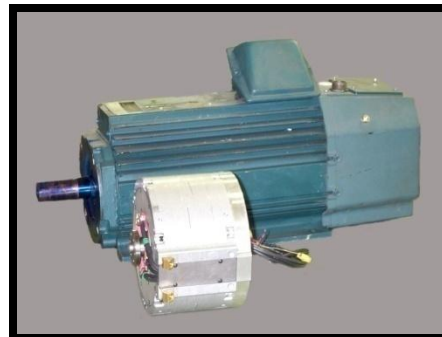
**Yesterday's
Conventional Radial Gap Stator**



**Tomorrow's
LE Axial Gap Stator**



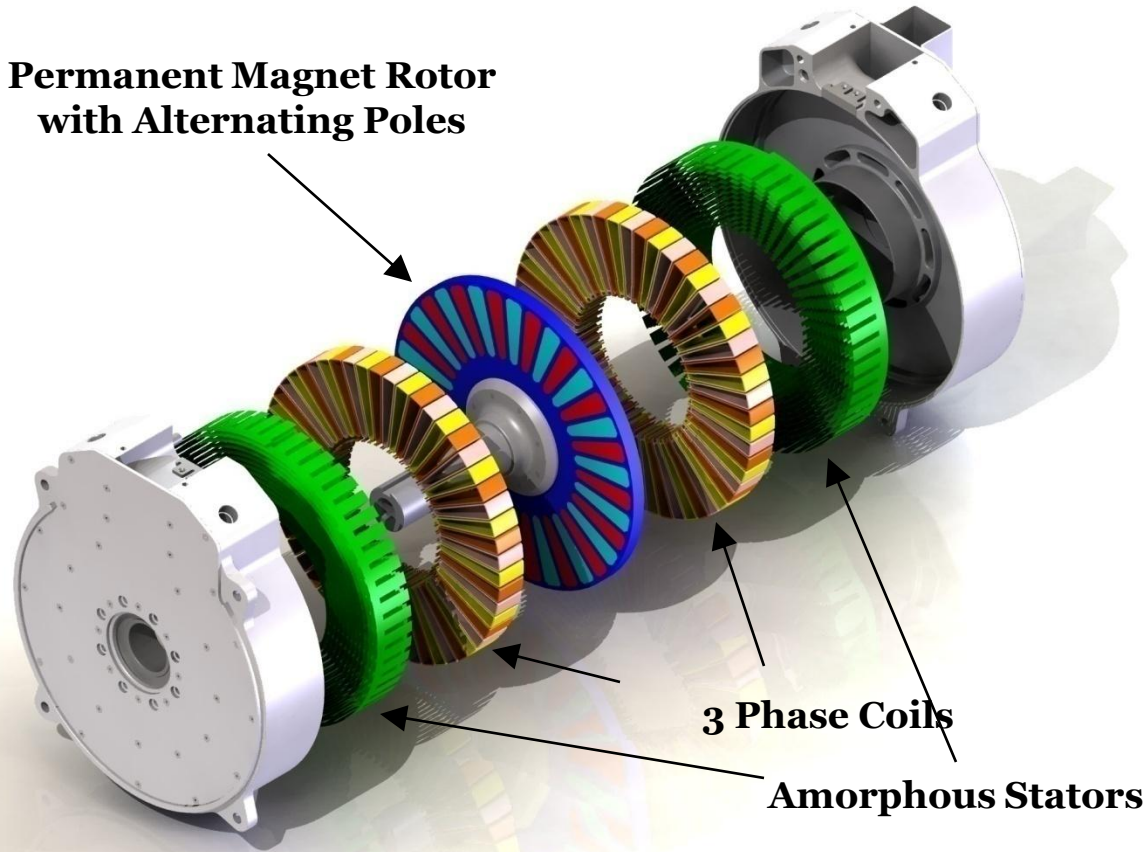
The result..... 1/3 the size and weight.... !!





Typical LE Machine Construction

**Permanent Magnet Rotor
with Alternating Poles**



3 Phase Coils

Amorphous Stators

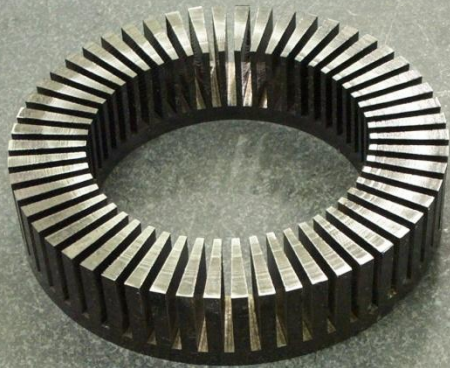
**LE SmartTorq™
M32L2**



Scalability of LE Stator Technology



Current 2.5 cm Stator



Current 24 cm Stator



**Current 60 cm
Stator**



Products/Markets

Advantages

- Power Dense Packaging
- High Efficiencies
- Durable Robust Design (TENV)
- Up to IP67



**LE GenSmart™ SG24B1
48VDC Charging System**

Battery Charging Systems

- Variable Speed Operation
- Proprietary Charge Controller
- Multiple Battery Chemistries Compatibility (Li, Nimh, Lead Acid)



**LE GenSmart™ SG24N1
72 VDC Charging system**



Products/Markets – Variable Speed Power Generation (VSG)

Fuel Savings

Variable Speed approach to power generation saves fuel. The prime mover only runs at a speed that is dependent on the electrical load on the system. This saves significant amounts of fuel when compared to fixed-speed gensets.

Reduced Emissions

Running the engine at variable speed reduces the overall emissions when compared to a fixed speed application

Improved Motor Starting Capability

Traditional gensets require 2.5 kW = 1 HP ratio for acceptable motor starting. The LE GenSmart™ Variable Speed Generator technology enables a 1 kW = 1 HP ratio. This eliminates the need to oversize the engine and generator for motor starting conditions.

Improved Performance

- Capable of 100% unbalanced loads
- Improved Power Quality (Very Low THD)
- No frequency deviation

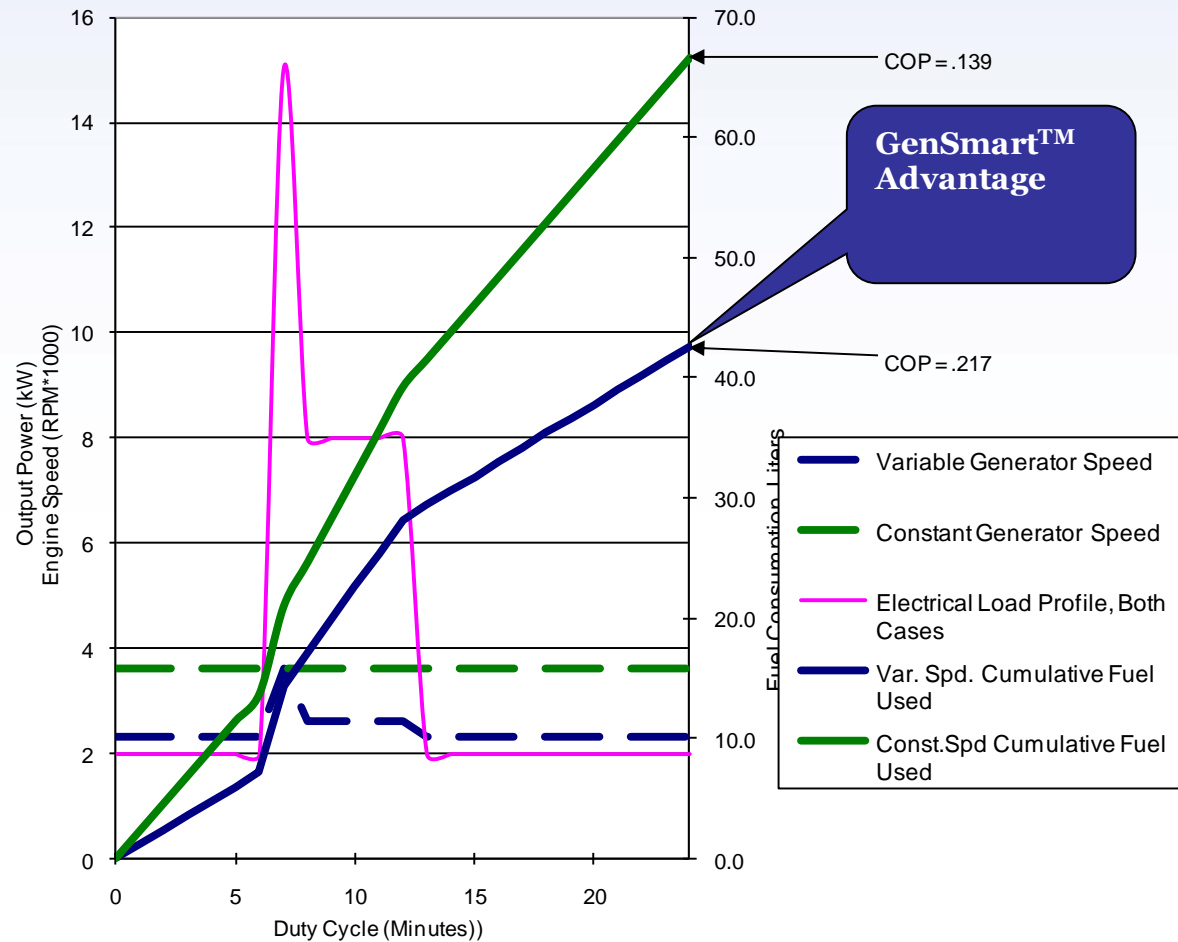


**LE GenSmart™
15 KW VSG System**



LE 15 kW GenSmart™ VSG Test Data

LE GenSmart™ Variable Speed Advantage
Supplying one motor start every 18 minutes, with 33% motor duty cycle.
Yanmar 3 Cylinder Diesel Engine with LE GenSmart™ COP based on
(Total Electrical Energy Out / Total Fuel Energy In)



Duty Cycle/ Minutes



LE GenSmart™ VSG Payback 15kW VSG

Time	Liters Saved	Gallons Saved
1 Day	23.9	6.3
365 Days	8724	2300
Fuel Cost	€ 1.29 / liter	\$3.00 / Gal
1 Year Savings	€ 11,254	\$6,900
2 Year Savings	€ 22,508	\$13,800

GenSmartTM
Advantage

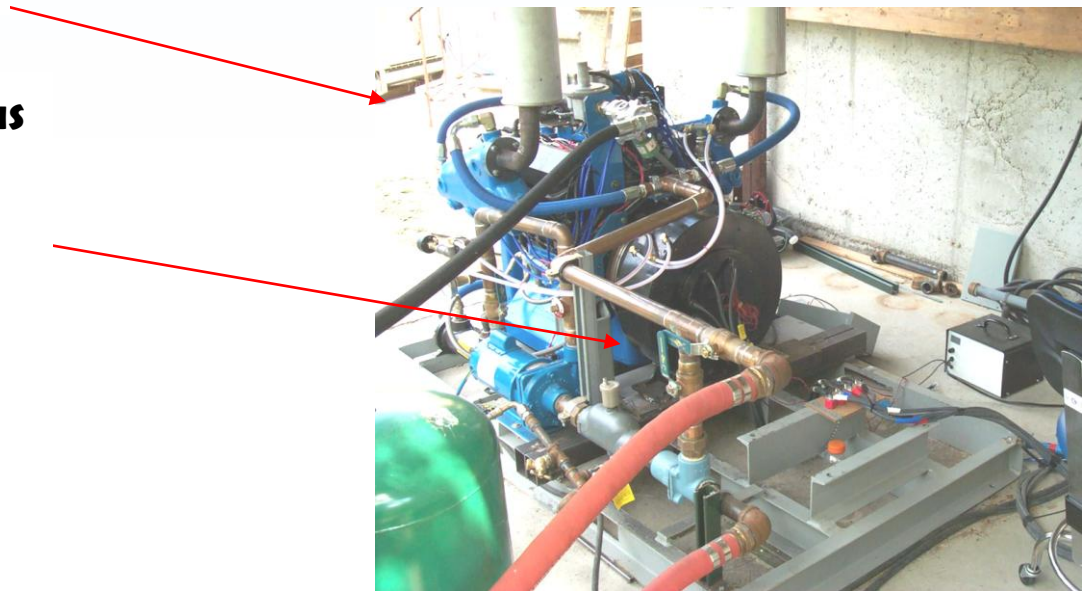


Ways of Saving Comparing with Synchronous Generator

Space/Weight – The generator is usually 3 – 5 times smaller and lighter
(depends on speed and output):

**100kW @ 2500rpm
TELC Generator**

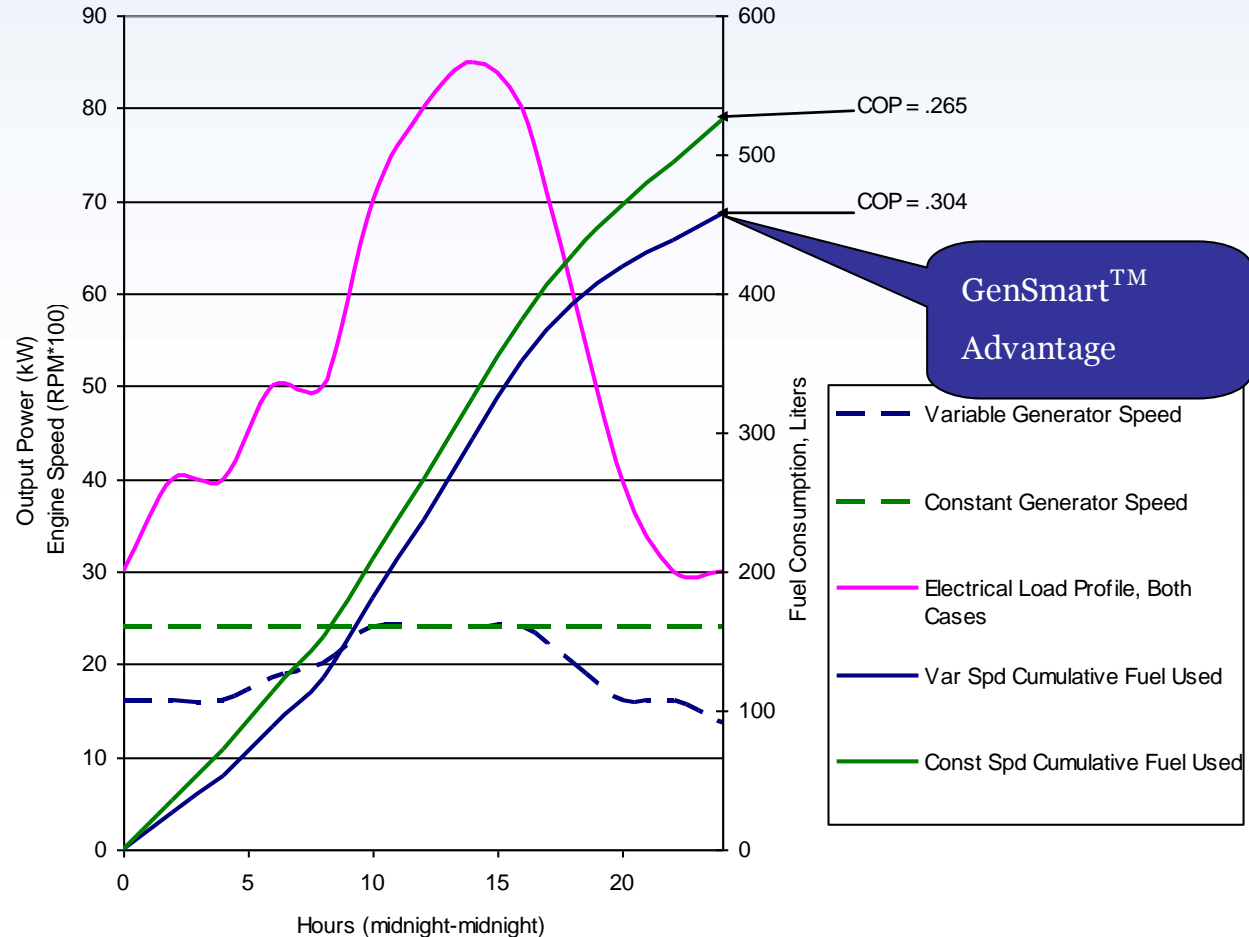
**Mounting base for previous
synchronous generator
(over 2' apart)**





LE 85 kW GenSmart™ VSG Test Data

LE GenSmart™ Variable Speed Advantage
Load profile from 35% to 100% over course of 24 hours
Cummins QSB Engine with LE GenSmart™ Generator and Inverter
COP based on (Total Electrical Energy Out / Total Fuel Energy In)





LE GenSmart™ VSG Payback

85 kW VSG

Time	Liters Saved	Gallons Saved
1 Day	69	18.2
365 Days	25,185	6,643
Fuel Cost	€ 1.29 / liter	\$3.00 / Gal
1 Year Savings	€ 32,489	\$19,129
2 Year Savings	€ 64,978	\$ 39,858

GenSmart™
Advantage



LE Model FR10

- **PTO driven variable speed, constant power system, 10 kw continuous over 800 – 3000 rpm speed range.**
- **M32N2 motor and HV860 drive**
 - **Compact Generator design 32 cm diameter, 14 cm axial length (Active Material)**
 - **Light weight 37 kg**
 - **720 volts dc max input to drive. Note: Must supply 12 vdc input to drive.**
 - **Drive size 22.3 inches long X 11.3 inches high X 11.4 inches deep**
 - **Air cooled system, further reduction of 40% possible with water cooling designs.**





PURELIGHT

FUEL SAVINGS

The LT 30-30 consumes significantly less fuel than comparable units. Fuel savings of 30% or more are typical.

EXTENDED RUN-TIME

Better fuel economy means longer run-time (30% Typical) on a given amount of fuel. This means less on site fill-ups to you resulting in less overall operating costs.

HIGH EFFICIENCY GENERATOR

The LE patented GenSmart™ generator runs at significantly higher efficiency rates than any other comparable generator in the Industry!

DURABLE DESIGN

Heavy gauge steel construction. Totally Enclosed Non-Ventilated (TENV) generator, suitable for harsh environments.

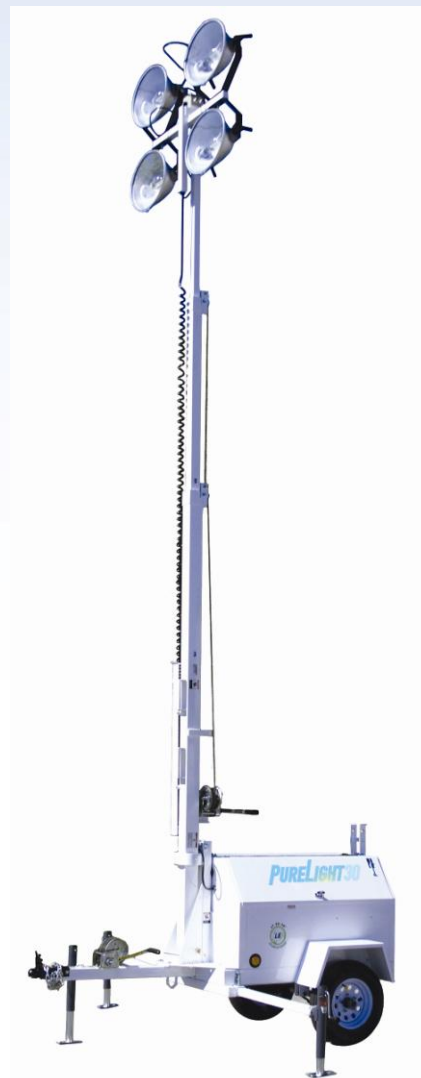
REDUCED EMISSIONS

Less fuel consumption means less emissions. The LT 30-30 is a more environmentally friendly choice.

REDUCED LIFE-CYCLE COSTS

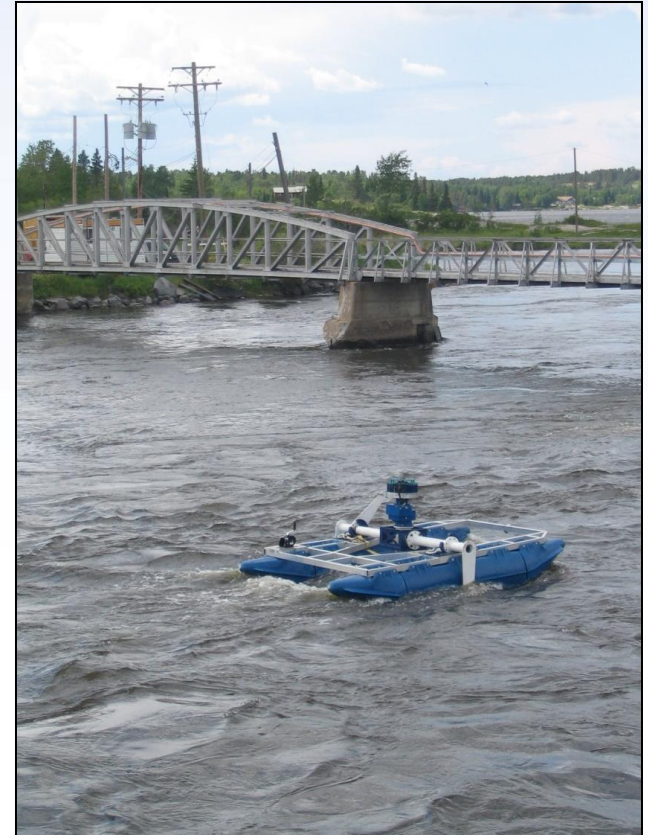
Cost effective purchase price, lower maintenance costs and reduced operating costs all add up to lower life-cycle costs.

PURELIGHT30





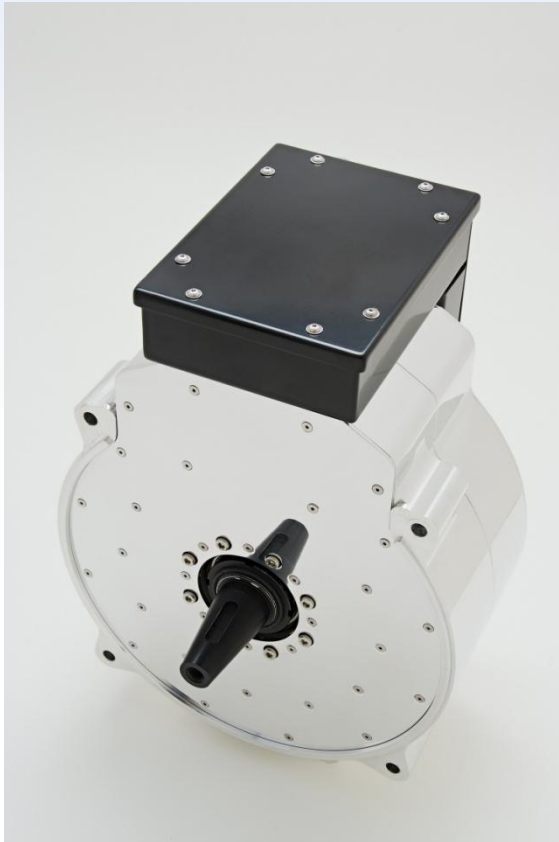
20 kw Portable Hydro Power System



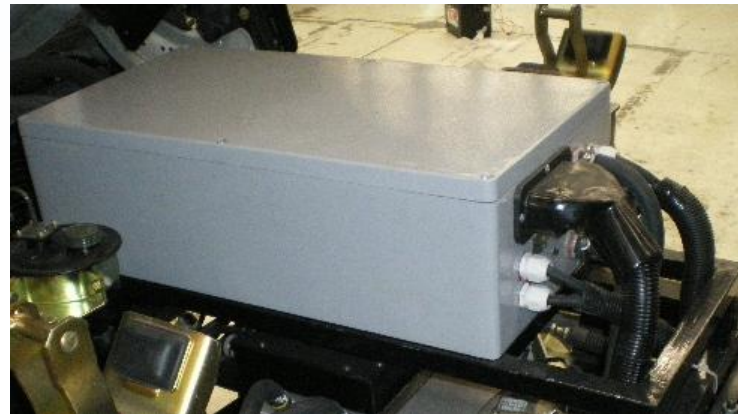


LE Traction Drive System

- **High Efficiency over broad speed range**
- **High power density**
- **45-80 kW**
- **Air and liquid cooled models**
- **Multiple voltage configurations**
- **High speed capability**
- **Durable design**



**LE SmartTorq™
M32L2**



LE 350 Vdc Motor Drive



Installation Pictures



LE M32L2



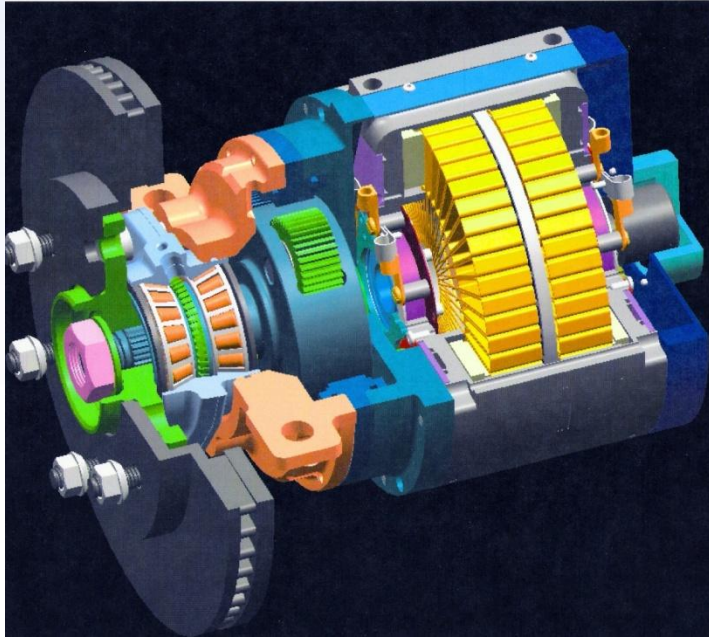
Sample Vehicles

EVI



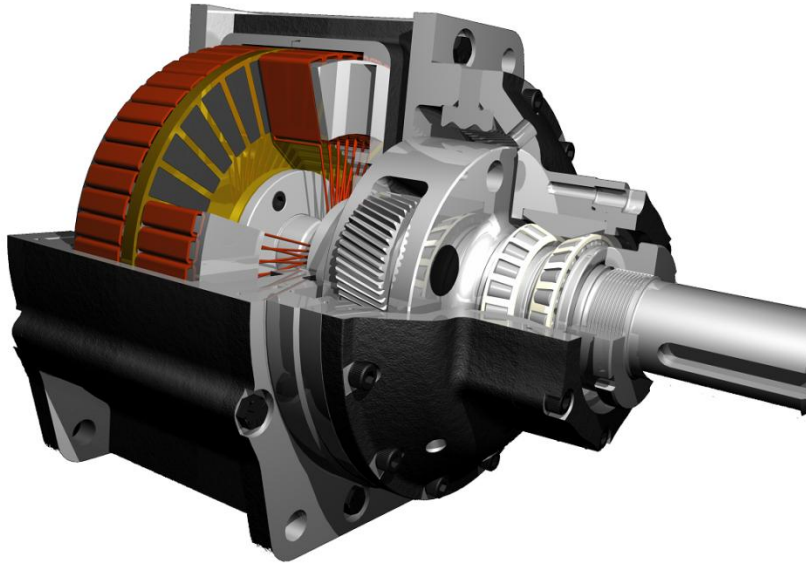


Integrated Wheel Motor Systems



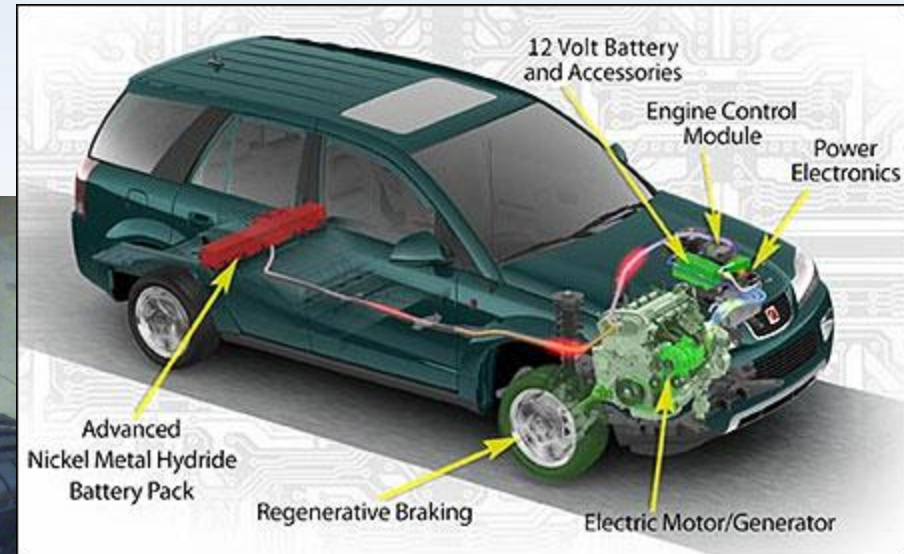


Power Pac II Series System





LE Powered Traction System





Longevity and Durability: Designed and Verified

Standard design for all product has been tested...

Longevity-3000+ hours on engine

1300 hours 2X speed

1600 hrs on engine, 20C to 120C Temp Cycling

Durability

Vibration Mil STD 167-1A

Survived sine dwell 4 – 33 Hz, 1g, while motoring

Shock Mil STD 810-F

Survived 3 ft (1 meter) hammer drop in 3 axes, while motoring

Survived 5 ft (1.5 meter) hammer drop, while not motoring

Shock levels exceeded 1000g



LE China, JV with DS Motor

Located in Shenzhen China





LE Summary

- LE has a strategic partnership in place with the largest producer of amorphous metal/Nano crystalline materials in the world. This will enable LE to control technology from both the patent and material sides.
- Multiple patent applications in process, best patent work is the most recent applications (22 Total), thus making a good patent runway.
- LE currently has machines through design and in production for power ranges 5-200 kW.
- LE has issued a technology license to Regal Beloit - Marathon Electric, the largest producer of motors & generators manufactured in the US.
- LE's technology represents one of the most significant advancements in rotating machine in the last 20 years.
- LE's goal is to become the **industry standard** for permanent magnet motors & generators in the next 5-7 years. It will accomplish this goal with a combination of licensing and manufacturing.



Coming Soon.....LESA !!



Research & Development Projects